STATEMENT OF
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Thank you for this opportunity to appear before you and testify on the likelihood and potential effects of a worst-case catastrophic earthquake in the New Madrid region. Earthquakes in the central and eastern United States are less common than in California or Alaska, but the hazard they pose is by some measures equally as significant. This is because central and eastern U.S. earthquakes affect much larger areas than earthquakes of comparable-size in the west and because most of the buildings and infrastructure in the central and eastern U.S. were built without consideration of seismic shaking. In the winter of 1811 and 1812 three major earthquakes struck the lower Mississippi Valley, profoundly affecting the region and felt even along the eastern seaboard. Thousands of aftershocks followed and continued for decades. If those events were to recur today, significant structural damage to buildings would occur in at least eight states. Additionally, more frequent, modest earthquakes can be locally devastating.

Hurricane Katrina was a stark reminder of the long-lasting impact that catastrophic natural hazard events can have on this nation. The lessons of Katrina come in the wake of those from the devastating earthquake and tsunami off the coast of northern Sumatra in

December 2004, underscoring the risk posed by infrequent but nevertheless very real events. Last fall, rescue efforts following the Pakistan earthquake, which killed over 80,000 people in mountainous regions north of Islamabad, were hampered by earthquake-triggered landslides that left key roads impassable, a reminder of the hazard posed by secondary effects of such events.

At the U.S. Geological Survey (USGS), we strive to deliver the information and tools that emergency managers, public officials and citizens need to prevent natural hazards from becoming disasters. The USGS has the lead Federal responsibility under the Stafford Act (P.L. 93-288) to provide notification – including forecasts and warnings where possible – for earthquakes, volcanoes and landslides. The USGS is a partner in the National Earthquake Hazard Reduction Program (NEHRP), working with the Federal Emergency Management Agency (FEMA), National Institute of Standards and Technology, National Science Foundation, and state and local governments. Catastrophic geologic hazard events including earthquakes, volcanoes, and tsunamis pose a significant threat to this Nation. In developing the Advanced National Seismic System (ANSS), USGS identified 26 urban areas with moderate to high seismic hazard. Part of the ANSS development has focused on instrumenting these urban areas, to provide information for emergency responders, engineering performance studies, and long-term earthquake hazard assessments. Steps such as these can reduce the impact of geologic events and keep them from becoming disasters.

The USGS Earthquake Hazards Program provides the scientific information and knowledge necessary to reduce deaths, injuries, and economic losses from earthquakes by providing timely notifications of earthquake locations, size, and potential damage; regional and national assessments of earthquake hazards; and increased understanding of the cause of earthquakes and their effects. National and regional seismic hazard maps depict earthquake shaking hazards and are used for creating and updating the seismic design provisions of building codes used in the United States. The USGS has recently begun developing higher-resolution maps and other products that focus on the most vulnerable urban areas; in the central and eastern U.S. these include Memphis, St. Louis, Evansville, and Charleston. Comparable USGS efforts are also underway in the San Francisco Bay and Seattle areas.

A Catastrophic New Madrid Earthquake Scenario

In the winter of 1811 and 1812, three earthquakes with moment magnitudes between 7.5 and 8.0 struck the lower Mississippi Valley over a two-month period. Although few people lived in the region at the time, the effects on the landscape remain clear 200 years later. Studies of the geologic record show that similar sequences of major earthquakes have happened previously, at least twice before about 1450 and 900 AD.

An earthquake with moment magnitude of 7.5 or greater would cause significant structural damage to buildings would occur in at least eight states. Lifelines crossing the region, including highways, bridges, and oil and gas pipelines leading to the northeastern

U.S. would be severely damaged, particularly in the Mississippi Valley. If the earthquakes were to occur when the Ohio and Mississippi Rivers were high, loss of levees is likely along with flooding of low-lying communities. The City of Memphis, with over 1 million people in its metropolitan area, would be the most affected urban center. Memphis has an aging infrastructure and many of its large buildings, including unreinforced schools and fire and police stations, are particularly fragile when subjected to severe ground shaking. Very few buildings were built using modern building codes that have some provision for seismic-resistant design.

Landslides occurred along the bluffs from Mississippi to Kentucky in connection with the 1811 and 1812 Mississippi Valley earthquake events. Today a repeat event could be expected to result in a similar scenario for downtown Memphis. At least one highway and one railroad bridge crossing the Mississippi River are unlikely to survive a major New Madrid earthquake and many old overpasses would likely collapse. A significant hazard in the New Madrid region is a type of soil failure called liquefaction, which in 1811 and 1812 affected a region from south of Memphis to St. Louis. Liquefaction causes soil to flow and form deep cracks that may make roadways in the Mississippi Valley of Arkansas and Missouri (such as I-55) impassible. The liquefaction can cause flooding of fields and roads with water, sand, and mud, disrupting agriculture for an extended period of time. Liquefaction and failure of levees and riverbanks could make the Mississippi River unnavigable - possibly for many weeks. Although Memphis is likely to be the focus of major damage in the region, St. Louis, Little Rock and many small and medium-sized cities would also sustain damage.

One characteristic of New Madrid earthquakes is particularly important to highlight. In 1811 and 1812 there was a sequence of large earthquakes within a three month period as opposed to a single large earthquake event. Geologic evidence suggests that such sequences of major earthquakes are characteristic of the region. This means that during recovery efforts, earthquakes as strong as the first shock can be expected to occur following the initial shock and must be considered when deciding where to shelter people and when to start rebuilding.

The USGS estimates that there is about a 10% chance of a major New Madrid earthquake occurring in the next 50 years. Additionally, the occurrence of a moderate-sized earthquake located in close proximity to urban centers like Memphis or St. Louis could be equally devastating locally. The USGS estimates the chances of a magnitude 6.0 or larger earthquake occurring in the New Madrid region in the next 50 years is 25-40%. Results from a recent regional-scale loss estimation study by FEMA suggest immediate losses from just one M7.7 New Madrid earthquake would total between $68 and $77 billion. However, additional studies will be required to assess potential losses from multiple earthquakes and to provide such assessments at scales appropriate for mitigation and response planning within the most vulnerable urban areas.

Preventing Disasters

Society's actions before natural hazard events will determine the magnitude of the losses. Science can tell us the likely consequences of a repeat New Madrid earthquake sequence. That information can be used to reduce the vulnerability of lifelines, retrofit critical structures, improve monitoring systems, develop scenarios, and educate our citizens.

- **Lifelines**. We can reduce the vulnerability of our lifelines by adopting fault-crossing technologies that allow the fault to move without rupturing the pipelines and other transportation systems, such as was used to prevent damage to the Alaska Pipeline during the 7.9 magnitude 2002 Denali earthquake. Although much of the Mississippi Valley is rural, many major pipelines traverse the region carrying needed resources to more populated urban centers nationwide.
- **Retrofitting**. Throughout the New Madrid seismic zone, there are numerous unreinforced masonry buildings that are particularly vulnerable to earthquake shaking. Recent seismic retrofits of two major highway bridges in Memphis and Cape Girardeau, including installation of seismic instrumentation to provide performance data, represent important steps in reducing our vulnerability.
- **Rapid information systems.** Modern seismic monitoring systems can provide information about the strong shaking and probable damage within minutes to support decisions by emergency responders. In some cases, information about the probability of shaking can be delivered before the shaking begins. The USGS supports networks operated by the University of Memphis and St. Louis University, which augment the national network and are crucial components of the Advanced National Seismic System (ANSS) being developed to provide more robust and reliable earthquake

reporting for urban areas.   In the New Madrid region robust, real-time, automated earthquake notification now is standard and products that have proven invaluable in western US earthquake responses are being tested (e.g., ‘ShakeMaps’, automatically generated, instrumental maps of shaking intensity).

- **Accurate scenarios.** An integrated picture of what will happen in a future earthquake event from rupture on the fault to shaking and damage of buildings and infrastructure is needed. To chart the road to full recovery from such an event there is a need to study and plan for the response at all levels including emergency response. Such analysis requires research on all aspects of the earthquake process, including: mapping the near-surface geology in the urban region; determining the location and geometry of all hazardous faults; measuring the seismic wave speed in near-surface materials; and deploying Advanced National Seismic System (ANSS) instruments in the ground to quantify the way earthquake waves travel in the region, and in key engineered structures to better predict how they will respond to severe shaking. These results would provide a complete picture of where mitigation would do the most good. Complete scientific analysis reduces uncertainty and further engineering evaluation will help reveal the actual level of vulnerability in our built environment and help prioritize retrofitting. The USGS conducts and sponsors research so that it can provide credible scenarios and other products for its partners in other Federal, State, and local agencies and the private sector. Activities in the central and eastern U.S. are particularly closely coordinated with those of FEMA’s sponsored Central United States Earthquake Consortium, and the state geological surveys in the region.

- **Education.** Our citizens will eventually be the true first responders to the next disaster. They need to be educated on the likely consequences of earthquakes, how to recognize a safe building, the importance of retrofitting and how to respond safely. In particular, education is the only viable approach to encourage the securing of contents of buildings. Damage to contents caused $12 billion of the $40 billion losses in the 1994 Northridge earthquake that struck southern California.

Natural hazard events during the past year underscore the need for timely, relevant scientific information. USGS efforts in hazards monitoring and long-term data and information collection from past and present hazard events is not simply a scientific research endeavor - - it is a matter of public safety.

Mr. Chairman, thank you for the opportunity to appear before you today. I am happy to answer any questions that you and Members of the Subcommittee may have.